What is claimed is:

1. A system for injecting a feed material into a plasma chamber to convert the feed material into a plasma, said plasma chamber having a substantially cylindrical wall centered on an axis and containing a plasma having a substantially azimuthal rotation about said axis, said system comprising:

an injector for introducing a fluid jet of said feed material into said chamber at a predetermined velocity and with a preselected jet radius, with said injector positioned and oriented to direct said fluid jet from said wall, transversely through said rotating plasma to a target volume in said plasma chamber, said target volume being located substantially on said axis; and

a means for vaporizing said feed material at said target volume to create a plasma from said feed material.

2. A system as recited in claim 1 wherein said vaporizing means comprises a laser source for creating a laser beam to irradiate said feed material at said target volume.

3. A system as recited in claim 1 wherein said vaporizing means comprises a microwave source for creating a microwave beam to irradiate said feed material at said target volume.

4. A system as recited in claim 1 wherein the feed material includes a compound selected from the group consisting of a metal oxide and a metal nitrate.

5. A system as recited in claim 4 wherein said compound is dissolved in a solvent selected from the group consisting of water and sodium hydroxide.

6. A system as recited in claim 1 wherein said fluid jet of feed material arrives at said target location as droplets.

7. A system as recited in claim 6 wherein said droplets have a diameter less that approximately 60μm.

8. A system as recited in claim 6 further comprising a means for producing vibrational energy to break up said droplets.

9. A plasma mass filter for separating a multi-constituent material into constituents, said plasma mass filter comprising:

a cylindrical shaped wall surrounding a plasma chamber and defining a longitudinal axis, said cylindrical shaped wall having a first end and a second end and being formed with at least one chamber inlet positioned therebetween;

means for generating a magnetic field in said chamber, said magnetic field being aligned substantially parallel to said longitudinal axis;

means for generating an electric field substantially perpendicular to said magnetic field to create crossed magnetic and electric fields, said electric field having a positive potential on said longitudinal axis and a substantially zero potential on said wall;

an injector for introducing a fluid jet of said multi-constituent material through said chamber inlet and into said chamber at a predetermined velocity and with a preselected jet radius, with said injector positioned and oriented to direct said fluid jet in a substantially radial direction from said wall to a target volume in said plasma chamber, said target volume being located substantially on said longitudinal axis; and

a means for vaporizing said multi-constituent material at said target volume to create a multi-species plasma having high-mass particles and low-mass particles in said chamber to interact with said crossed magnetic and electric fields for ejecting said high-mass particles into said wall and for confining said low-mass particles in said chamber during transit therethrough to separate said low-mass particles from said high-mass particles.

10. A filter as recited in claim 9 wherein said vaporizing means comprises a laser source for creating a laser beam to irradiate said multi-constituent material at said target volume.

11. A filter as recited in claim 9 wherein said vaporizing means comprises a microwave source for creating a microwave beam to irradiate said multi-constituent material at said target volume.

12. A filter as recited in claim 9 wherein said vaporizing means comprises a vibrational excitation source for injected droplets.

13. A filter as recited in claim 9 wherein said chamber inlet is positioned substantially midway between said first end of said wall and said second end of said wall.

14. A filter as recited in claim 9 wherein “e” is the charge of the particle, wherein said wall is at a distance "a" from said longitudinal axis, wherein said magnetic field has a magnitude "B_z" in a direction along said longitudinal axis, wherein said positive potential on said longitudinal axis has a value "V_{ctr}", wherein said wall has a substantially zero potential, and wherein said low-mass particle has a mass less than M_c, where

$$M_c = ea^2(B_z)^2 / 8V_{ctr}.$$

15. A filter as recited in claim 9 wherein said means for generating said magnetic field is a magnetic coil mounted on said wall.

16. A filter as recited in claim 9 wherein said means for generating said electric field is a plurality of conducting rings mounted to said first end of said wall and centered on said longitudinal axis at one end of said chamber.

17. A method for injecting a feed material into a plasma chamber to convert the feed material into a plasma, said plasma chamber having a substantially cylindrical wall centered on an axis and containing a plasma having a substantially azimuthal rotation about said axis, said method comprising the steps of:

selecting a target volume located substantially on said axis;

injecting a fluid jet of said feed material into said chamber at a predetermined velocity and with a preselected jet radius, wherein said fluid jet is oriented to deliver said feed material from said wall, transversely through said rotating plasma to said target volume in said plasma chamber; and

vaporizing said feed material at said target volume to create a plasma from said feed material.

18. A method as recited in claim 17 wherein said predetermined velocity and said preselected jet radius are selected to minimize evaporation of said fluid jet between said wall and said target volume.

19. A method as recited in claim 17 wherein said predetermined velocity and said preselected jet radius are selected to minimize deflection of said jet by said rotating plasma.

20. A method as recited in claim 17 wherein said fluid jet of said feed material arrives at said target location as droplets.

21. A method as recited in claim 17 further comprising the step of dissolving said feed material in a solvent selected from the group consisting of water and sodium hydroxide.

22. A method as recited in claim 17 wherein said vaporizing step is accomplished by irradiating said fluid jet of said feed material at said target volume with a laser beam.